調査

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動向

・A series of recent breakthroughs have achieved long elusive results for both classical and quantum LDPC codes. On the quantum side, good qLDPC codes have now been constructed. On the classical side, we now have good cLDPC codes that are also locally testable. Ref[1]

わかっていること

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In good codes, both the code rate k (the number of logical qubits encoded) and the code distance d (the size of the smallest undetectable error) are proportional to n (the number of physical qubits), which is the optimal scaling.

・When defined on expander graphs, qLDPC codes can give rise to so-called “good codes” that combine a finite encoding rate with an optimal scaling of the code distance, which governs the code’s robustness against noise.

・it has been known for decades that expander graphs allow for the construction of good classical LDPC (cLDPC) codes

・consider any pair of boxes in Tanner graph, reppresenting an X-check and Z-check. In a valid Tanner graph the number of circles connected to both boxes must be even.

・The dierence between stabilizer and subsystem codes is that the subsystem code does not impose the condition that these check operators should commute with one another and hence in general there is no interpretation of a subsystem code as a chain complex Ref[2].

問題

・The construction of good quantum LDPC codes which are also locally testable is still an outstanding challenge.

・qLDPC で code distance を physical qubit の個数に対して線形にすることがめちゃくちゃ challenging.

REFERENCES

[1] Tibor Rakovszky and Vedika Khemani, The Physics of (good) LDPC Codes I. Gauging and dualities, arXiv:2310.16032v1

[2] Matthew B. Hastings, Fiber Bundle Codes: Breaking the N1=2 polylog(N) Barrier for Quantum LDPC Codes, arXiv:2009.03921v2

要調査

・超伝導やシリコンスピンで取り除かなければならない異質とは何か
・中性原子の parasitic charge とは
・中性原子の配列をグラフ理論の点に対応させることで問題を解ける
・中性原子の量子ビット再配列方法
・analog simulation の可能性
・nFT state preparation
・feedforward と mid-circuit measurement の違い
・Instataneous Quantum Polynomial
・braiding で d 以上動かすとどうなるのか
・easy intialization と difficult intialization はどっちがいいのか
・toric code in magnetic field(ising model)
・bacon-shor code
・neutral adn traped ion approaches rely on light scattering for entropy removal
・中性原子の measurement free な protocol
・Sisyphus cooling
・magic intensity, magic-wavelenghth tweezers
・spin echo pulse, magic trapping
・code distance の求め方
・LDPC code では、あんまり冗長性がありすぎてもいけない
・エラーの種類はなぜ bit-flip と phase flip だけなのか？